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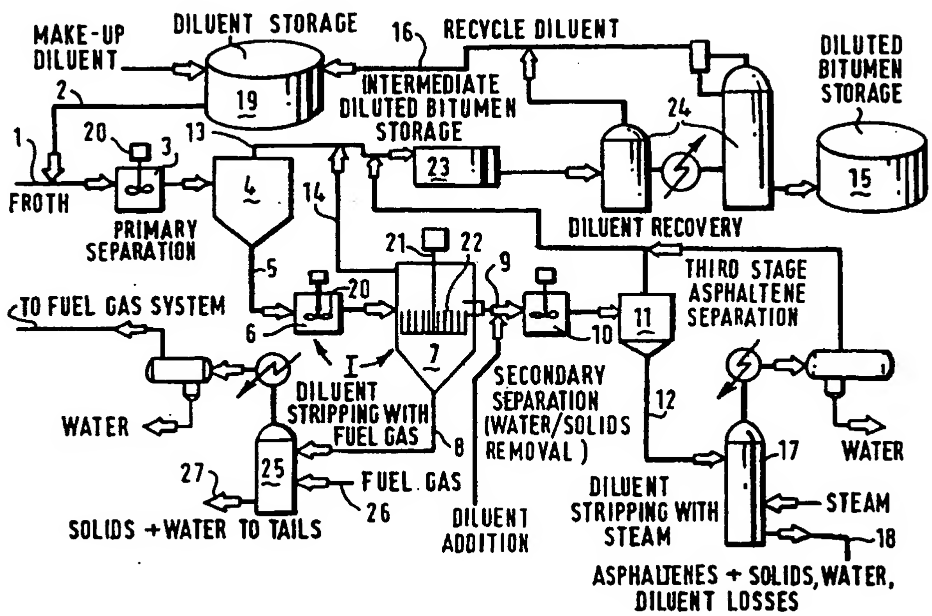
(54) **METHODE POUR TRAITER UNE ECUME DE SABLES BITUMINEUX DILUEE**

(54) **METHOD FOR PROCESSING A DILUTED OIL SAND FROTH**



(57) Méthode pour traiter une écume de sable bitumineux, retirée sous forme de flux de sous-écoulement (5) à partir d'une cuve (4) de séparation primaire de l'écume de bitume. La méthode consiste à agiter énergiquement le sous-écoulement dans une cuve (6), avec un taux de cisaillement permettant d'agglomérer les asphaltènes et les argiles tout en limitant la redispersion des agglomérés ainsi formés, et de séparer ces derniers, sous forme de flux de mixtes (9), des autres constituants, p. ex. dans une cuve de séparation secondaire (7), dans laquelle l'écume est légèrement agitée.

(57) A method for processing an oil sand froth that is withdrawn as an underflow stream (5) from a primary bitumen froth separation vessel (4) comprises the steps of vigorously agitating the underflow in an agitating tank (6) at such a shear level that agglomerates of asphaltenes and clays are formed whilst redispersion of the thus formed agglomerates remains limited and separating said agglomerates as a middlings stream (9) from the other components e.g. in a secondary separation vessel (7) in which the froth is gently agitated.

A B S T R A C T

METHOD FOR PROCESSING A DILUTED OIL SAND FROTH

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(FIG. 1)

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METHOD FOR PROCESSING A DILUTED OIL SAND FROTH

The invention relates to a method for processing a diluted oil sand froth.

More particularly, the invention relates to a method for processing a diluted oil sand froth that contains hydrocarbons, water, clays and coarse solids and that is withdrawn from a lower part of a primary fluid separation vessel of a paraffinic solvent froth treatment unit in an oil sand processing plant.

In such a plant mined oil sand is mixed with water to produce a slurry whereupon the slurry is screened to remove oversize rocks and oil sand lumps. The thus generated pumpable slurry is subsequently conditioned by the combined action of selectively wetting the sand, softening of the hydrocarbons and mechanical agitation and then fed to a bitumen extraction process.

The bitumen froth produced from the bitumen extraction process is mixed with a paraffinic diluent or solvent and fed to a primary separation vessel to initiate inversion of the emulsion. This will cause dilute bitumen globules to rise and form a dilute bitumen upper layer. This dilute bitumen is subsequently withdrawn from the overflow of the vessel and further treated.

The other components of the inverted emulsion which separates into a dense fluid, containing water, solids, clays and hydrocarbon emulsion enriched in asphaltenes are withdrawn as an underflow from the lower part, usually the bottom, of the primary separation vessel. These components are then usually further treated in a secondary separation vessel and/or a cyclone or a

decanter centrifuge to separate the water/solids phase from the asphaltenes, bitumen and diluent.

Canadian patent specification No. 940,853 discloses a tar sand processing method in which a propane-butane solvent is mixed with tar-oil froths to make an emulsion that can be broken and separated in a controlled fashion.

The specification describes a rag layer with agglomerated asphaltics formed between the lower layer of water and solids and the upper layer of hydrocarbon and solvent when the ratio of solvent to oil is sufficiently high (page 3, lines 9 to 31). The known solvent is restricted to propane-butane combinations. The teachings do not include any direction on stirring to promote agglomeration of asphaltenes and clays in the underflow.

Further, an article entitled "Measurement of asphaltene flocculation in bitumen solutions" published in the Journal of Canadian Petroleum Technology, October 1986, Volume 25, No. 5, pages 33-37 describes a series of tests in which solvent addition to bitumen triggers asphaltene precipitation.

US patent specifications 4,765,885, 4,891,131 and 5,017,281 disclose the use of a separation tank in which ultrasonic sound waves are transmitted to separate an aqueous tar sand slurry into a liquid hydrocarbon oil fraction which rises to the top of the suspension and to cause asphaltenes and preasphaltenes to form charcoal-like agglomerates which settle to the bottom of the tank. The known tank is equipped with a mixing blade which is rotated during the separation process but which generates only a relatively low level of turbulence such that gravity separation still takes place.

US patent specification No. 4,906,355 discloses a tar sand extraction process in which a tar sand slurry is mixed with specific solvents having limited solubility for asphaltenes, notably C_3-C_7 alkanes and corresponding

petroleum fractions, to form agglomerates of asphaltenes and mineral fines. A substantial portion of these agglomerates are subsequently gravitationally separated in a lamella separator to avoid substantial attrition of the agglomerates.

A problem encountered with the known separation systems is that asphaltenes and fine clays are difficult to remove from the slurry, so that in order to achieve an acceptable purity of any waste water and tailings, complex and expensive waste water and tailings cleaning facilities are required.

The present invention aims to provide a method for treating the underflow of a paraffinic solvent primary separation vessel such that any asphaltenes and clays can be removed in an efficient and effective manner.

The method according to the invention thereto comprises the steps of:

- agitating the underflow stream at such a shear level that agglomerates of asphaltenes and clays are formed whilst dispersion of the thus formed agglomerates remains limited;
- separating at least a substantial portion of said agglomerates from the other components of the underflow stream; and
- withdrawing the thus separated agglomerates as a separate product stream.

Preferably the underflow stream is agitated by an impeller which is located in an agitating tank and which is driven at a power rate which is between 0.5 and 5 kW per m^3 of the volume of the agitating tank.

It is also preferred that the agitated underflow stream flowing from the agitating tank is fed into a secondary separation vessel in which the fluid mixture is agitated at a lower shear rate than in the agitating tank, which lower shear rate is low enough to maintain

the agglomerates of asphaltenes and clays within an intermediate fluid layer but high enough to release other hydrocarbons into an upper fluid layer and to release water and coarse solids into a lower fluid layer within said vessel and which vessel is equipped with a lower fluid outlet through which at least a substantial proportion of water and coarse solids are removed from the vessel, an intermediate fluid outlet through which at least a substantial proportion of said agglomerates of asphaltenes and clays are withdrawn from the vessel and an upper fluid outlet through which at least a substantial proportion of other hydrocarbons are removed from the vessel.

In that case it is preferred that the underflow stream is gently agitated in the secondary separation vessel by means of a stirring device which is slowly rotated at a power rate which is between 0.1 and 0.5 kW per m^3 of volume of the secondary separation vessel.

These and other features, objects, aspects and advantages of the method according to the invention are disclosed in the accompanying claims, abstract, drawings and detailed description with reference to the drawings.

The invention will now be described in more detail with reference to the accompanying drawings, in which:

Fig. 1 depicts a schematic flow-scheme of a paraffinic solvent froth treatment plant in which arrows I point at an agitating tank and secondary separation vessel in which the method according to the invention is applied; and

Fig. 2 depicts a schematic flow-scheme of a simplified paraffinic solvent froth treatment plant in which arrows II point at an agitating tank and secondary separation vessel in which the method according to the invention is applied and where a third stage separation vessel is not present.

Referring now to Fig. 1, stream 1 represents a stream of bitumen froth comprising a mixture of bitumen, water and solids to which a stream 2 of paraffinic diluent is added typically at a ratio of about two volumes of diluent per volume of bitumen in the slurry stream 1.

The diluent and slurry are subsequently mixed in a mixing tank and fed to a primary separation vessel 4.

The bitumen froth stream 1 typically contains 25-30% by weight water, some of which is free water carried over to the froth during extraction, and approximately 5% of the water which is in the form of a micro-emulsion in the bitumen with droplet sizes of 2-10 microns. Mixing of this froth with the above-mentioned quantity of paraffinic diluent in the mixing tank 3 results in the destabilization of the emulsion and the subsequent formation of a rag layer at the hydrocarbon/water interface in the primary separation vessel 1. Furthermore, the diluent/froth ratio is above the inversion point of the emulsion which results in the precipitation of more asphaltenes, with the resulting reduction of asphaltenes in the hydrocarbon product overflow stream 13 from the primary separation vessel.

The underflow 5, containing water, solids and hydrocarbon emulsion enriched in asphaltenes, is withdrawn from the conical bottom of the primary separation vessel 4 and fed into an agitating tank 6 in which an impeller 20 agitates the fluid mixture at such a shear level that agglomerates of asphaltenes are formed but that redispersion of the thus formed agglomerates remains limited. To achieve this relatively high shear level the impeller 20 is typically rotated at a power rate of between 0.5 and 5 kW per m^3 of volume of the agitating tank 6. In the agitated underflow small asphaltene agglomerates are formed in which the very fine clays present in the emulsion are co-absorbed.

The agitated underflow stream is subsequently fed into the secondary separation vessel 7 which is designed to provide sufficient retention time to allow a hydrocarbon phase to be recovered from the top of the vessel 7 as an overflow stream 14 comprising mainly hydrocarbon and diluent and for a mainly asphaltene agglomerates containing middle layer to be formed and to be discharged as an asphaltene-rich middlings stream 9 from the middle of the vessel and an underflow 8 of water and solids which is relatively hydrocarbon-free to be discharged from the bottom of the vessel 7.

A stirring device 21, inside vessel 7, agitates the middle layer at such a shear level to encourage the asphaltene-rich middle layer to agglomerate and release water and solids into the lower fluid layer and hydrocarbons and diluent into the upper fluid layer. To achieve this relatively low shear, the stirring device is rotated at a power rate between 0.1 and 0.5 kW per m^3 of volume of the secondary separation vessel.

The middlings stream 9 is subsequently fed to a third stage mixing tank 10 and asphaltene separator vessel 11 to disperse asphaltene agglomerates to promote diluent recovery in a steam stripping unit 17 in which the asphaltene-rich underflow stream 12 from the third-stage separation vessel 11 is treated.

The overflow stream of the third stage separation vessel 11 is combined with the overflow streams 13 and 14 of the first and second separation vessels 4 and 7 and fed into an intermediate diluted bitumen storage tank 23. These overflow streams are then processed in a two-stage diluent recovery flash unit 24 in which diluent is flashed and thereby separated from the bitumen. Subsequently a diluted bitumen underflow stream is discharged into a diluted bitumen storage tank 15 and a recycled diluent overflow stream 16 is discharged into

the diluent storage tank 19 which is the diluent supply source for the diluent stream 2 that is mixed with the agitated underflow stream 1.

The underflow stream 8 of the secondary separation vessel 7, which stream 8 mainly comprises coarse solids and water, with very small quantities of hydrocarbon and tramp asphaltenes is fed into a stripping unit 25 in which fuel gas is added to remove any small quantity of diluent from the solids and waste water stream 27.

The schematic flow scheme depicted in Fig. 2 is identical to that depicted in Fig. 1 except that the third stage separation vessel 11 is removed and that no relatively hydrocarbon free diluent is added to the asphaltenes rich middlings stream 9 that is withdrawn from the secondary separation vessel 7. In this simplified configuration the third stage mixing tank 10 is still present to disperse the asphaltene agglomerates that are fed to the steam stripping unit 17.

For a description of the other components depicted in the flow scheme of Fig. 2 reference is made to the detailed description with reference to Fig. 1.

In all embodiments of the method according to the invention that are depicted in the drawings the shear level generated in the agitating tank is crucial to the formation of asphaltene agglomerates in which the ultra-fine clays are co-absorbed.

The following procedure was followed in a laboratory test of the method according to the invention.

A sample of bitumen froth underflow was obtained from a froth treating pilot plant and put in beaker. The volume of bitumen froth underflow sample was 500 ml. The composition of the bitumen froth underflow sample was as follows: bitumen - 15.2% weight, asphaltenes content of bitumen - 5.2% of weight of sample, solvent -

30.4% weight, solids - 10.9% weight and water - 43.5% weight.

The bitumen froth underflow sample was stirred with an air driven impeller rotating at the speed of 500 rotations per minute for ten minutes. The power rate at which the impeller was driven was about 3 kW per m^3 of volume of the beaker. The speed of rotation of the impeller was such to impart sufficient shear to the mixture to encourage formation of agglomerates of asphaltenes and co-absorption of the asphaltenes with the very fine clays but not so much shear as to cause the agglomerated asphaltenes to redisperse. The mixture was then allowed to settle and a middle layer of asphaltenes began to form. This middle layer was stirred gently which encouraged it to release water and solids into a lower layer and hydrocarbons and solvents into an upper layer. These layers were removed and their respective volumes and compositions were measured or deduced to be as follows:

Upper layer: Volume = 50 to 75 ml. Composition = bitumen - 33.3% weight, asphaltenes content of bitumen in upper layer - 3.7% of weight of upper layer, solvent - 66.6% weight, solids - 0% weight and water - 0.1% weight.

Middlings layer: Volume = 200 ml. Composition = bitumen - 17.1% weight, asphaltenes content of bitumen in middlings layer - 13.7% of weight of middlings layer, solvent - 34.4% weight, solids - 14.3% weight and water - 34.2% weight.

Lower layer: Volume = 250 to 275 ml. Composition = bitumen - 0.1% weight, asphaltenes - 0% weight, solvent - 0% weight, solids - 16.6% weight and water - 83.3% weight.

The results described above were unexpected, as follows. The upper layer was virtually devoid of water and solids and the lower layer was virtually devoid of hydrocarbon. The middlings layer contained a significant proportion of the asphaltenes present in the treated sample. These asphaltenes can be removed and handled as a separate stream. Further, the middlings stream contains the very fine clays in the asphaltene agglomerates. Removal of these very fine clays in this fashion makes subsequent handling of the lower layer and disposal of solids less troublesome.

C L A I M S

1. A method for processing an oil sand froth containing hydrocarbons, water, clays and coarse solids that is withdrawn as an underflow stream from a lower part of a primary fluid separation vessel of a paraffinic solvent froth treatment unit in an oil sand processing plant, the method comprising the steps of:

- agitating the underflow stream at such a shear level that agglomerates of asphaltenes and clays are formed whilst dispersion of the thus formed agglomerates remains limited; and
- separating at least a substantial portion of said agglomerates from the other components of the underflow stream; and
- withdrawing the thus separated agglomerates as a separate product stream.

2. The method of claim 1, wherein the underflow stream is agitated by an impeller which is located in an agitating tank.

3. The method of claim 2, wherein the impeller is driven at a power rate which is between 0.5 and 5 kW per m^3 of the volume of the agitating tank.

4. The method of claim 2 or 3, wherein the agitated underflow stream flowing from the agitating tank is fed into a secondary separation vessel in which the fluid mixture is agitated at a lower shear rate than in the agitating tank, which lower shear rate is low enough to maintain the agglomerates of asphaltenes and clays within an intermediate fluid layer but high enough to release other hydrocarbons into an upper fluid layer and to release water and coarse solids into a lower fluid layer within said vessel and which vessel is equipped with a

lower fluid outlet through which at least a substantial proportion of water and coarse solids are removed from the vessel, an intermediate fluid outlet through which at least a substantial proportion of said agglomerates of asphaltenes and clays are withdrawn from the vessel and an upper fluid outlet through which at least a substantial proportion of other hydrocarbons are removed from the vessel.

5. The method of claim 4, wherein the underflow stream is gently agitated in the secondary separation vessel by means of a stirring device which is slowly rotated about a substantially vertical axis of rotation and which is equipped with a number of rakes and/or pickets.

6. The method of claim 5, wherein the stirring device is driven at a power rate which is between 0.1 and 0.5 kW per m^3 of volume of the secondary separation vessel.

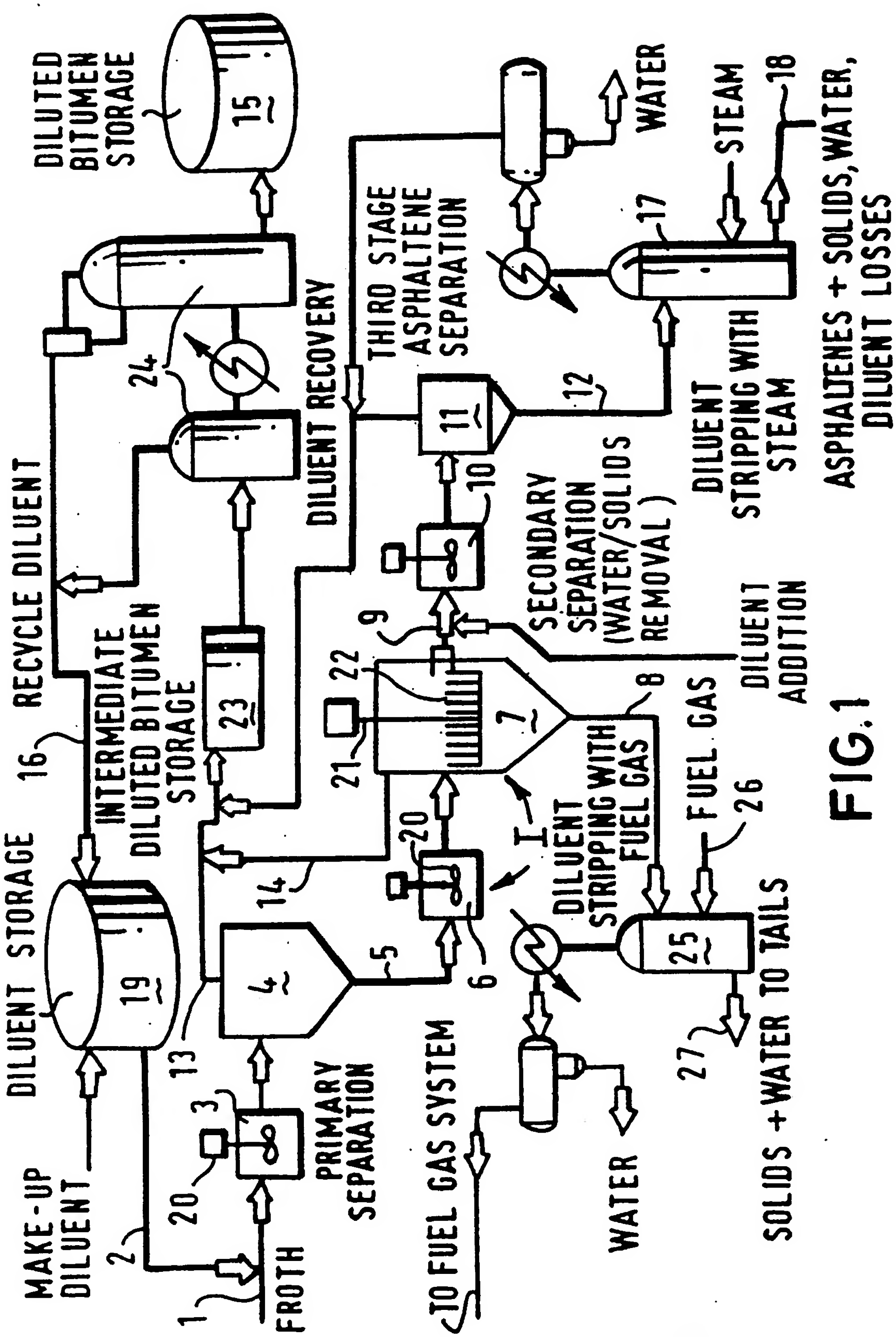

FIG.1

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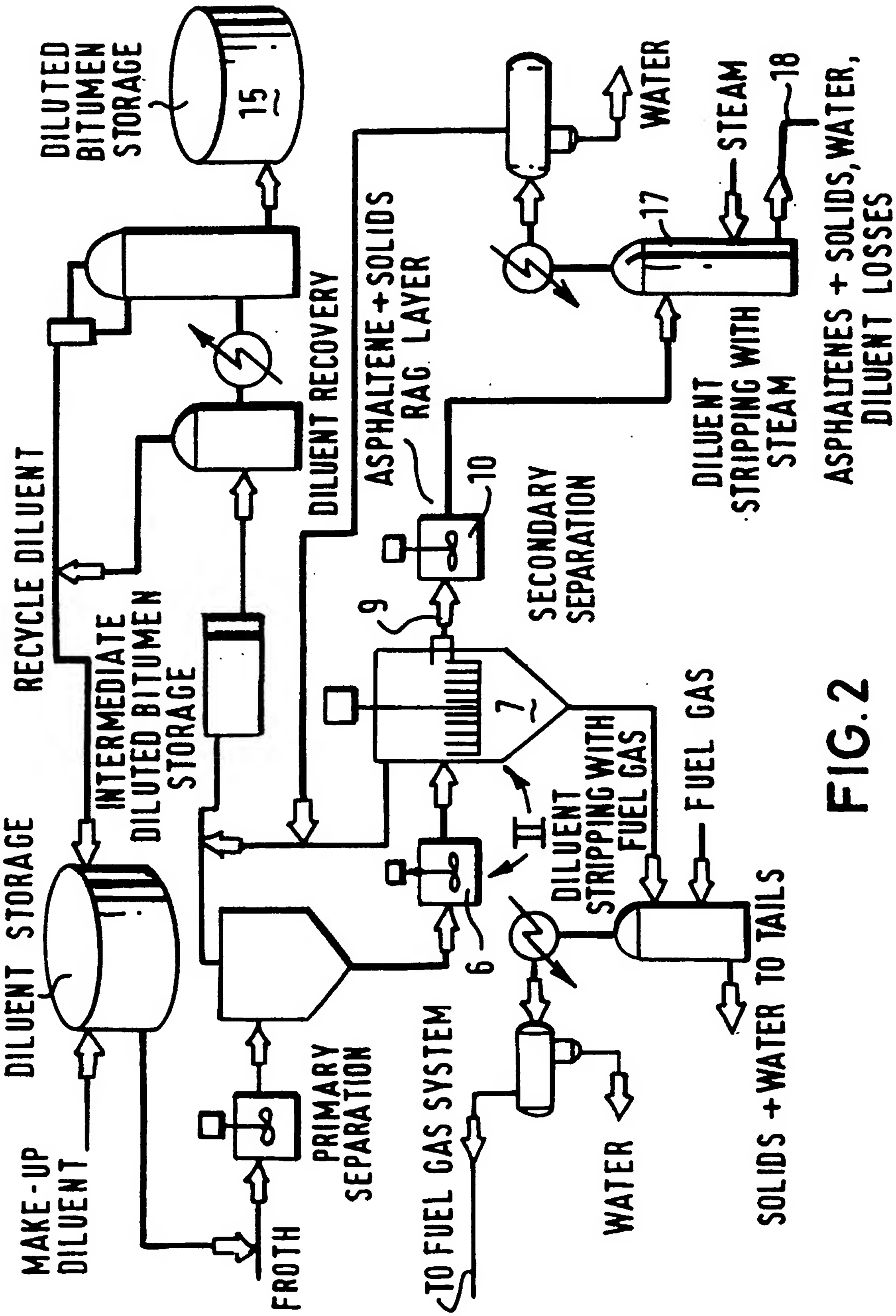

FIG.2

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